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Vol. V SEPTEMBER, 1918 No. 7

BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

PROCEEDINGS

PAPERS IN THIS NUMBER.

"The Cambridge, Mass., System of Real Estate Assessments." Stoughton Bell.

"The Newton, Mass., Water-Works Reservoir." Edwin H. Rogers.

Memoirs of Deceased Members.

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Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

Hull, Mass., June 19, 1918. — A regular meeting of the Boston Society of Civil Engineers was held at the Pemberton Inn this afternoon, after a shore dinner which was served in connection with the Joint Field Day and Excursion of the New England Water Works Association and this Society.

Immediately following the dinner the two societies were favored with an address by Major Kenneth D. Marlatt, of the Fourth Canadian Mounted Rifles. Major Marlatt spoke most earnestly of war conditions in France gained from his year and a half of active service at the front, and impressed on his audience the terrible conflict that was still before the Allies before there was any hope of a lasting peace.

At the close of his address a rising vote of thanks was extended to him by the two organizations, for his inspiring words.

The meeting of the Society was called to order by President Charles M. Spofford at about three o'clock, and by vote the reading of the record of the last meeting was postponed until the September meeting. The Secretary reported for the Board of Government that it had elected to membership in the grades named the following candidates:

Members — Holbert W. Fear, John B. Hanna, Laurence B. Hoyt, Benjamin H. Snow and Stanley W. Woodbury.
Junior — Mark Aronson.

The Secretary also presented a memoir of Past President John W. Ellis, prepared by Mr. J. Parker Snow, the committee appointed for the purpose, and by vote the memoir was accepted and ordered printed in the JOURNAL of the Society.

The total attendance was 114, including members of the New England Water Works Association and ladies.

Adjourned.

S. E. TINKHAM, *Secretary.*

WORCESTER, MASS., June 5, 1918. — To-day forty-three members and guests of the Sanitary Section of the Boston Society of Civil Engineers inspected the Worcester sewage purification works and experimental activated sludge plant.

A special trolley car was provided by the city of Worcester, which took the Section to Greenwood Park where a short address of welcome was given by the mayor of Worcester. Superintendent Gault and Mr. Lanphear gave brief descriptions of the plant.

The party was then entertained at lunch by the city officials after which several hours were spent in inspecting the purification works.

HENRY A. VARNEY, *Clerk.*

APPLICATIONS FOR MEMBERSHIP.

[September 10, 1918.]

The By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

Berkowitz, S. Ross, Boston, Mass. (Age 24, b. New York, N. Y.) From 1912 to 1914, student at Mass. Inst. of Technology. During summers of 1910 and 1911, draftsman with Coolidge and Carlson, architects, Boston; summers of 1912 and 1913, rodman and inspector with Engrg. Dept., town of Brookline; summer of 1914, laborer and assistant foreman with Stone & Webster on new Technology buildings; from 1915 to date, steel foreman, timekeeper, assistant superintendent, estimator and engineer with W. F. Kearns Co.; is now constructing engr. on U. S. Quartermaster Terminal, Boston. Refers to W. W. Bigelow, F. H. Fay, C. R. Gow, W. F. Kearns, H. F. Sawtelle and Gilbert Small.

Bowman, Bion A., West Roxbury, Mass. (Age 30, b. Braintree, Mass.) Graduate of Mass. Inst. of Technology, 1909, civil engineering course, degree of S.B. From June to November, 1909, structural steel draftsman with Post & McCord, New York, N. Y.; from November, 1909, to March, 1912, assistant engr. with Boston Elevated Railway Co. on Cambridge Main Street subway; from March, 1912, to March, 1915, assistant engr. with Boston Transit Comm.; also engaged in private work on concrete and steel highway and railway bridges and concrete building construction; from March, 1915, to date, with Fay, Spofford & Thorndike, Boston; is now division engr. in charge of superstructure division of Boston Quartermaster Terminal. Refers to E. S. Davis, F. H. Fay, H. F. Sawtelle, C. M. Spofford, G. F. Swain and S. H. Thorndike.

Farwell, Carroll Andrew, Hyde Park, Mass. (Age 35, b. Boston, Mass.) Graduate of Mass. Inst. of Technology, 1906, civil engineering course. From 1906 to 1907, assistant on Engrg. Corps, Pittsburgh Div., Pennsylvania Lines S. W., on general maintenance work; from 1907 to 1910, engineering aid, junior and assistant engineer with U. S. Reclamation Service in Montana, North Dakota, and Washington, D. C., on irrigation work; from 1910 to 1911, assistant superintendent on construction of electrolytic cells for Chemical Engrg. and Operating Co., Rumford, Me.; from 1911 to 1914, with Pearson Engrg. Corp'n of New York as assistant and resident engr. on layout and construction of main canal of Medina Irrigation Co. near San Antonio, Tex., on investigation and report on concrete canal lining as used throughout western United States, and as resident engr. on construction of concrete dam near Barcelona, Spain; from 1915 to date, with Fay, Spofford & Thorndike, Boston; is now division engr. of substructures for U. S. Quartermaster Terminal, Boston. Refers to W. W. Bigelow, J. S. Lamson, B. A. Rich, H. F. Sawtelle, F. P. Spalding and S. H. Thorndike.

Garvey, John Charles, Lowell, Mass. (Age 32, b. Lowell, Mass.) Graduate of Lowell Evening High School and Evening Drawing School; student for one year in structural engineering class of Lowell Textile School; has taken structural engineering course with American School of Correspondence. Was draftsman and estimator for four years with Baker Construction Co., Lowell, and superintendent of construction with William Drapeau for two years; was draftsman for three years and chief engr. for four years with E. J. Cross Co., Worcester; has been associated with Aberthaw Construction Co., Boston, for past eight months, and is now in charge of estimating dept. of their Philadelphia office. Refers to L. H. Allen, J. R. Nichols, C. R. Perry, G. H. Stearns and E. A. Tucker.

Giles, Ernest Palmer, Boston, Mass. (Age 24, b. Kerrville, Tex.) Graduate of Mass. Inst. of Technology, 1918, architectural engineering course, degree of S.B. and certificate in naval architecture. From May 28, 1918, to date, ship draftsman with Hull Div., Boston Navy Yard. Refers to J. B. Babcock, 3d; R. E. DeMerritt; J. J. Harty, Jr.; L. J. Johnson; Dean Peabody, Jr.; and J. E. Roy.

Hanlon, James Edward, Dorchester, Mass. (Age 27, b. Boston, Mass.) Received technical education from evening-school courses covering period of six years and including courses at Mechanic Arts High, Boston Architectural Club and Franklin Union. From March, 1906, to August, 1913, rodman, note keeper on surveys, and draftsman with Lockwood, Greene & Co., Boston; from August, 1913, to August, 1918, architectural engr. and draftsman with James E. McLaughlin, architect, Boston; from August, 1918, to date, structural engr. and draftsman with Bay State St. Ry. Co. Refers to J. J. Casey, J. P. Gallagher, E. A. Norwood and L. J. St. Amand.

Mellish, Murray Holman, Malden, Mass. (Age 33, b. Hebron, Nova Scotia.) Graduate of Mass. Inst. of Technology, 1910, civil engineering course. During summers of 1908 and 1909, employed on estimating and superintending of plumbing and heating work; from graduation to July, 1914, rodman, transitman, draftsman, computer and assistant engineer with consulting engineers, on hydraulic, railroad and general civil engineering work in field and office; from July, 1914, to April, 1917, resident engineer on civic improvement work and engineer on special work for town of Winchester; from April, 1917, to date, with engineering contractors; is now engineer with J. G. White Engineering Corporation of New York, and since June, 1917, has been chief engineer on construction work of Langley Field Aeronautical Experimental Station, Hampton, Va. Refers to C. F. Allen, H. K. Barrows, A. S. Crane, E. C. Sherman, C. M. Spofford and E. A. Tucker.

ROLL OF HONOR.*

ADDITIONS.

ALLEN, RAYMOND C. Captain, Q. M. C., U. S. Quartermaster Terminal, South Boston, Mass.

DONOVAN, FREDERICK P. Ensign, U. S. Naval Station, Havre, France.

† GAUTHIER, ALMON I. Master Engineer, Headquarters, 14th Engrs. (Ry)., Am. Exped. Force, France.

HALL, CHARLES LORING, Private, 7th Co., C. A. C., U. S. A., Portsmouth, N. H.

HARRIS, GILBERT M. 5th Co., 152d Depot Brigade, Camp Upton, N. Y.

JOHNSON, GEORGE A. Major, Q. M. C., N. A., Const'n Div., Maintenance and Repair Branch, Washington, D. C.

† KERSTEIN, BENJAMIN H. Private, Ordnance Corps, N. A., Detach. D, Edgewood Arsenal, Edgewood, Md.

† ROBINSON, ASHLEY Q. Musician, 334th Field Artillery Band, 87th Div., Headquarters Co., Camp Dix, N. J.

ST. AMAND, LOUIS J. Camp Upton, N. Y.

ULLIAN, HYMAN B. Chief Machinist's Mate, U. S. N. R. F., acting as inspector on construction of U. S. Naval Radio Camp, Cambridge, Mass.

WOODBURY, STANLEY W. 24th Co., Det. 6th B'n, Depot Brigade, Camp Devens, Mass. (Overflow "O" St.)

WRIGHT, EDWARD, Jr. Captain, Sanitary Corps, Fort Oglethorpe, Ga.

REVISIONS.

BALCH, WILLIAM H. Captain, Engrs., U. S. R., A. P. O. 717, care of Engr. Depot Officer, Am. Exped. Force, France.

BRESTH, ALEXANDER. 2d Lieutenant, Sanitary Corps, N. A., Camp Greenleaf, Fort Oglethorpe, Ga.

BURLEIGH, WILLARD G. Corporal, Topographical Section, Headquarters, 3d Army Corps, A. P. O. 754, Am. Exped. Force, France.

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* Members who are in the service and have not yet reported that fact to the Secretary are earnestly requested to do so, stating branch of service, rank and military address.

† Home address given below in "List of Members."

Cross, Ralph U. 2d Lieutenant, Q. M. C., N. A., Office of Q. M. General, 18th St. and Virginia Ave., Washington, D. C.

Durham, Henry Welles. Major, 41st Engrs., N. A., Am. Exped. Force, France.

Enebuske, Carl C. Acting Master Gunner, Headquarters Co., 55th C. A. C., Am. Exped. Force, France.

Gunby, Frank M. Colonel, Construction Div., Q. M. C., N. A., 7th and B Sts. S. W., Washington, D. C.

Hastie, Frank B. Captain, Corps of Engrs., Camp Laurel, Md.

Hobson, George F. Captain, 305th Engrs., U. S. R., Am. Exped. Force, France.

Hubbard, Carl P. 1st Lieutenant, Co. C, 11th Engrs. (Ry.), Am. Exped. Force, France.

Kendall, Theodore R. 1st Lieutenant, Sanitary Corps, N. A., care of Camp Surgeon, Camp Lee, Petersburg, Va.

Monaghan, James F. Major, Ord., N. A., Const'n Section, Supply Div., Ordnance Dept., 6th and B Sts. N. W., Washington, D. C.

Richardson, Edward B. Major, 1st B'n, 101st Field Artillery, U. S. N. G., Am. Exped. Force, France.

Sawyer, George S. Sergeant, Co. A, 504th Engrs. B'n, Am. Exped. Force, France.

Smith, William H. Lieutenant, Asst. C. E., C. E. C., U. S. N., Public Works Office, Norfolk Navy Yard, Portsmouth, Va.

Walker, Elton D. Captain, Co. A, 15th U. S. Engrs., Am. Exped. Force, France.

Webb, DeWitt C. Commander, Civil Engr. Corps, U. S. N., Public Works Officer, Navy Yard, Philadelphia, Pa.

Wood, Frederic J. Major, Engr. R. C., Const'n Div., War Dept., Room 3-341, 7th and B Sts. S. W., Washington, D. C.

Worcester, Robert J. H. 1st Lieutenant, Engrs., N. A., Co. C, 602d Engrs., Am. Exped. Force, France.

LIST OF MEMBERS.

ADDITIONS.

Aronson, Mark........................25 Lawrence Ave., Roxbury, Mass.
Fear, Holbert W...U. S. Geological Survey, Custom House, Boston, Mass.
Gauthier, Almon I.............................Box 105, Groton, Mass.
Kerstein, Benjamin H..............20 Canterbury St., Dorchester, Mass.
Steward, Harry M..........................101 Milk St., Boston, Mass.

CHANGES OF ADDRESS.

Blake, Edmund M.,
Care of Aberthaw Const'n Co., Liberty Plant, Alameda, Calif.
Boas, Benjamin...........Care of Monks & Johnson, Sparrows Point, Md.
Carter, Gale A...................58 Palace Hill, Quebec, P. Q., Canada

Clukas, George M. . . . . 4 Colliston Rd., Brookline, Mass.
De La Haye, Elias F., Jr. . . . . 67 Manthorne Rd., West Roxbury, Mass.
Dolliver, Henry F. . . . . 3 Pine St., Belmont, Mass.
Ellis, Leslie B. . . . . 594 Franklin St., Melrose, Mass.
Emerson, George D. . . . . 162 Walnut St., Brookline, Mass.
Flett, Louis E. . . . . Care of Otis Co., Ware, Mass.
Hunter, William B. . . . . Grand Gorge, N. Y.
Jerrett, Robert . . . . . 12 Garden St., Elmwood Sta., Providence, R. I.
King, Arthur C. . . . . 44 Berkeley Ave., Lansdowne, Pa.
Linenthal, Mark . . . . . Care of Liberty Shipbuilding Co., Brunswick, Ga.
Manley, Laurence B. . . . . 1825 Wylie St., Philadelphia, Pa.
Moses, Ernest M. . . . . 5 Washington Ave., Cambridge, Mass.
Newman, Rolf R. . . . . 1446 Carroll Ave., Los Angeles, Calif.
Robinson, Ashley Q. . . . . 53 4th St., Attleboro, Mass.
Robinson, Harold L. . . . . 19 Hartshorne Ave., Worcester, Mass.
Shute, George P. . . . . 1713 Baird Ave., Portsmouth, Ohio
Sokoll, Jacob M. . . . . Care of Aberthaw Const'n Co., Sparrows Point, Md.
Sumner, Merton R. . . . . P. O. Box 20, Wilmington, Del.
Turner, Charles C. . . . . 5126 North 10th St., Philadelphia, Pa.
Wood, Dana M. . . . . 22 Myrtle St., Belmont, Mass.

DEATHS.

Buss, Edward A. . . . . August 18, 1918.
Coburn, Howard L. . . . . June 19, 1918.

EMPLOYMENT BUREAU.

The Board of Government has established an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

423. Age 37. Received technical education from four years' course at Lawrence Scientific School. Has had thirteen years' experience, including some water-works engineering, but chiefly on elevated and subway construction. Desires position as engineer in charge of work or as inspector. Salary desired, $60 to $70 per week, depending on location of work.

LIBRARY NOTES.

Recent Additions to the Library.

On Military Engineering and Related Subjects.

Handbook of Ship Calculations, Construction and Operation. Charles H. Hughes.

Naval Constructor. George Simpson.

U. S. Government Reports.

Annual Report of Interstate Commerce Commission on Statistics of Express Companies in United States for 1914–15 and 1915–16.

Annual Report of Reclamation Service for 1904–5. Gift of H. A. Carson.

(The) Bowdoin Dome, Montana: A Possible Reservoir of Oil or Gas. Arthur J. Collier.

Bull Mountain Coal Field, Montana. L. H. Woolsey and others.

Clay-Working Industries and Building Operations in Larger Cities in 1916. Jefferson Middleton.

Concentration Experiments with Siliceous Red Hematite of Birmingham District, Alabama. Joseph T. Singewald, Jr.

Feldspar in 1916. Frank J. Katz.

Graphite in 1916. Henry G. Ferguson.

Lake Clark-Central Kuskokwim Region, Alaska. Philip S. Smith.

Lambert Projection: Tables for United States; General Theory of Lambert Conformal Conic Projection. Both by Oscar S. Adams.

Landscape Engineering in National Forests. Frank A. Waugh.

Lime in 1916. G. F. Loughlin.

Manganese at Butte, Montana. J. T. Pardee.

Mineral Waters in 1916. Arthur J. Ellis.

Oil-Storage Tanks and Reservoirs. C. P. Bowie.

Our Mineral Supplies: Copper, by B. S. Butler; Portland Cement, by Ernest F. Burchard; Iron, by same; Magnesite, by Hoyt S. Gale; Alaska's Mineral Supplies, by Alfred H. Brooks.

Range Preservation and Its Relation to Erosion Control on Western Grazing Lands. Arthur W. Sampson and Leon H. Weyl.

Red, White and Blue Series: War, Labor and Peace.

Results of Observations Made at United States Coast and Geodetic Survey Magnetic Observatory near Tucson, Arizona, 1915 and 1916. Daniel L. Hazard.

Results of Physical Tests of Road-Building Rock in 1916 and 1917.. Prévost Hubbard and Frank H. Jackson, Jr.

Siliceous Dust in Relation to Pulmonary Disease among Miners in Joplin District, Missouri. Edwin Higgins and others.

Slate in 1916. G. F. Loughlin.

Structure of Northern Part of Bristow Quadrangle, Creek County, Oklahoma, with reference to Petroleum and Natural Gas. A. E. Fath.

Technology of Salt Making in United States. W. C. Phalen.

Tests of Absorption and Penetration of Coal Tar and Creosote in Longleaf Pine. Clyde H. Teesdale and J. D. MacLean.

Typical Specifications for Bituminous Road Materials. Prévost Hubbard and Charles S. Reeve.

Water-Supply Papers 426, 437.

State Reports.

Connecticut. Annual Report of Highway Commissioner for 1917.

Connecticut. Annual Report of Public Utilities Commission for 1916–17.

Massachusetts. Annual Report of Gas and Electric Light Commissioners for 1917.

Massachusetts. Annual Report of Metropolitan Park Commissioners for 1917.

Massachusetts. Annual Report of Metropolitan Water and Sewerage Board for 1917.

Massachusetts. Report of Commission on Waterways and Public Lands on Water Resources of Massachusetts, Their Conservation and Utilization, 1918.

Massachusetts. Report of Street Railway Investigation Commission on Problems Relating to Street Railways of Commonwealth, 1918. Gift of H. S. Knowlton.

Michigan. Annual Reports of State Board of Health for 1915–16 and 1916–17.

New Jersey. Annual Report of Department of Health for 1917.

New Jersey. Annual Report of State Highway Department for 1917.

New Jersey. Department of Conservation and Development: Annual Report for 1917; A Shade-Tree Guide, 1918, by Alfred Gaskill.

New York. Reprints from Annual Report of State Department of Health for 1915 as follows: Disposal of Human Excreta and Sewage of Country Home, by Theodore Horton; Reduction of Water-borne Typhoid Fever, by same; Study of Application of Score System to Sanitary Quality of Public Water Supplies in New York State, by Theodore Horton and E. Sherman Chase; Relation of Sewerage Systems to Prevalence of Typhoid Fever, by H. Burdett Cleveland; Design of Separate Systems of Sewerage for Villages with Special Reference to New York State Conditions, by C. A. Holmquist; Liquid Chlorine Disinfection of Water for Potable Purposes, by C. M. Baker; Effect of Calcareous Material in Soils and Rocks on Amount of Nitrates in Ground and Surface Waters, by M. F. Sanborn.

West Virginia. Sanitary Survey of Charleston, W. Va.

Municipal Reports.

Bangor, Me. Annual Report of Water Board for 1917–18.

Brockton, Mass. Annual Report of City Engineer for 1917.

Brockton, Mass. Annual Report of Sewerage Commissioners and City Engineer for 1917.

Burlington, Vt. Annual Report of Water Department for 1917.

Chelsea, Mass. Annual Reports of Water Commissioner for 1916 and 1917.

Denver, Colo. Annual Report of Department of Improvements and Parks for 1917.

Fall River, Mass. Annual Report of Watuppa Water Board for 1917.

Lowell, Mass. Annual Reports of Commissioner of Water Works for 1916 and 1917.

Marlborough, Mass. Annual Report of Water and Sewage Commission for 1917.

Medford, Mass. Annual Report of Water and Sewer Commissioners for 1917.

New Bedford, Mass. Annual Report of Engineering Department for 1917.

New Orleans, La. Semiannual Report of Sewerage and Water Board, December 31, 1917.

New York, N. Y. Annual Report of Board of Water Supply for 1917.

Newton, Mass. Annual Report of Street Commissioner for 1917.

Pittsfield, Mass. Annual Report of Board of Public Works for 1917.

St. Paul, Minn. Annual Report of Water Commissioners for 1917.

Waltham, Mass. Annual Report of City Engineer, Superintendent of Water Works, and Sewers for 1917.

Woonsocket, R. I. Annual Report of Water Commissioners for 1917.

Worcester, Mass. Annual Report of Superintendent of Sewers for 1917.

Miscellaneous.

Brooklyn Engineers' Club: Proceedings for 1916.

Canada, Department of Mines: Annual Report on Mineral Production of Canada for 1916, by John McLeish; Analyses of Canadian Fuels, Parts I, III–V, by Edgar Stansfield and J. H. H. Nicolls; Report on Clay Resources of Southern Saskatchewan, by N. B. Davis.

Carnegie Endowment for International Peace: Year Book, 1918.

Concrete Engineers' Handbook. George A. Hool and Nathan C. Johnson. Gift of McGraw-Hill Book Co., Inc.

E. I. du Pont de Nemours & Co.: Du Pont Products.

Institute of Makers of Explosives: Clearing Land of Rocks for Agricultural and Other Purposes, by J. R. Mattern; Clearing Land of Stumps; Use of Explosives in Making Ditches; Use of Explosives in Tillage of Trees.

National Board of Fire Underwriters: Reports and Bulletins on following cities: Albany, N. Y.; Allentown, Pa.: Atlanta, Ga.; Battle Creek, Mich.; Boston, Mass.; Burlington, Vt.; Chester, Pa.; Grand Rapids, Mich.; Hamilton, Ohio; Joplin, Mo.; Kansas City, Mo.; Little Rock, Ark.; Los Angeles, Calif.; Louisville, Ky.; Mobile, Ala.; New Britain, Conn.; Newport, R. I.; Norwich, Conn.; Philadelphia, Pa.; Pittsburgh, Pa.; Portland, Ore.; San Diego, Calif.; Springfield, Mo.; Springfield, Ohio; West New York, N. J.; Wheeling, W. Va.; Wichita, Kan.

Standards of Department of Health and Sanitation of United States Shipping Board Emergency Fleet Corporation, 1918.

LIBRARY COMMITTEE.

Vol. V SEPTEMBER, 1918 No. 7

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

THE CAMBRIDGE, MASS., SYSTEM OF REAL ESTATE ASSESSMENT.

By Stoughton Bell, Esq.*

Your President has spoken briefly of the organization of the commission in Cambridge, which was appointed by the mayor at the request of a citizens' meeting. Its purpose was to look into the subject of real estate assessment in Cambridge. As originally appointed it was a commission of five. We have a fortunate arrangement in Cambridge with the Massachusetts Institute of Technology and with Harvard University by which the mayor may request the heads of each of those institutions to designate some one to assist in municipal work. Harvard appointed, at the mayor's request, Professor Bullock, who is now president of the National Tax Association and the head of the Department of Economics at Harvard, — a thorough expert in taxation matters. Technology appointed your Presi-

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[Note. — The President of the Society, Charles M. Spofford, who introduced the speaker, stated that the committee of which Mr. Bell was chairman was appointed by Mayor Good, of Cambridge, and consisted of Cambridge business men supplemented by a representative of Harvard University and a representative of the Massachusetts Institute of Technology. This committee, after a careful study of systems of real estate valuation in other cities, decided to appoint an engineer to make a detailed study and devise a system for Cambridge. Mr. E. O. Christiansen was appointed for this work.]

* Of Putnam, Putnam & Bell, 60 State Street, Boston.

dent, Professor Spofford, the head of the Civil Engineer Department. We were appointed in December, 1914, and for three or four months made an investigation of assessments in the city of Cambridge. We also made an investigation of assessments of the cities and towns throughout New England, and in March, 1915, reported to the mayor that it was our belief that the city of Cambridge could introduce a plan which would value all real estate on a proportionately equal basis. We recommended and asked that the committee to establish the system, when appointed, should have an appropriation and should have an engineer to take charge of the work, and we recommended the adoption of the system which was later put in force.

That recommendation was acceptable to the mayor and the city council. An appropriation was granted and an engineer appointed, who was sent to make investigations in cities which had systems already installed in other parts of the United States. He went to Newark, Buffalo, Baltimore and New York, where offices were opened to him for a very complete study. We had made a very careful survey of the situation in Cambridge, and had utilized all the departments of the city that we could for assistance. One of the most useful was the planning department. We asked them to tell us something about assessments in the city of Cambridge, — if they could not picture them for us so that we could see them with the eye as well as look at the figures, — and they worked out a scheme of coloring the map of the city. The highest valuation, shown in black, was at Harvard Square and at Central Square. The white areas represented land assessed under five cents per square foot, and the black areas land valued at fifteen dollars per square foot. Here is a thing I like to point out when I am calling this to any one's attention. We have recently had a good deal of agitation in the legislature concerning the burden upon the city of the exempted property of the University. I like to point out that the most appreciable area of high-priced land in the city is immediately southwest of the College yard, which is exempt. There is a little that is high at Central Square and a little bit at Porter's Station, but at Harvard Square is the property that is the most highly valued in the city.

Assessments in New England are a growth of long standing. The assessors have, in the majority of instances, found the value upon their books, and have had no machinery and no method by which they could revalue the entire city. They have gone into districts and placed a higher or lower value in that district, but so far as we could find from our investigation there has been no machinery placed in the hands of any assessors in the New England States that would be of any real assistance to them in placing a fair value upon land. Here is an illustration of the result. There is a little rooster-shaped piece of high-valued land located in the Norton estate, which is undergoing development. I think it is a fair deduction to say that the reason that high-priced land lies in a lower-priced district is because that land has been developed and has been called to the attention of the assessors, and the result has been that where a new house has gone up an increase has been put upon the land under it.

The assessors of the city of Cambridge had the best lot and block maps that we found in any of the New England States. These were in existence when we took hold of this work. But in order to see any large district it became necessary for the assessors to put a half dozen tables together and then place the maps one against another, and should one of the assessors' coats push against the picture puzzle it was gone and had to be readjusted. These lot and black maps covered the entire city of Cambridge. They showed the streets and the lot lines, the kinds of construction, wood in yellow, brick in red, stone or cement buildings in gray, etc. Such maps are absolutely necessary, we believe, for any assessors' offices, and in this instance they were the only plans which were in the assessors' offices. They had asked for appropriations for large maps but had been unable to get them.

Besides these, we had a study by the planning board with the values represented in color, and another plan showing by cross-hatching and other symbols the character of the development in different parts of the city. With that map and with other maps which will be made, the assessors may see how the development is changing from year to year, from the effect of houses going up and the large increase of apartments which will occur, largely due to the subway connection with Boston. The map gives a bird's-eye view of the purposes to which property is put. In addition to that, we had a clerk go to the registry of deeds and obtain for us, during the time that the war tax was on, the consideration of deeds as expressed in stamps. We had a record of recent mortgages which were put on property, and we made a careful study of rentals throughout the city, and these we had expressed in color form on a map. The rentals ran from $15 to $20 in dark blue up to $20 and over in yellow. Brown represented $10 to $15 and pink from $5 to $10. Whenever we saw a sign in a window "For Rent," we found out what the asking price was; and we kept the telephone wires busy for a little while, getting the figures for this chart. An interesting thing shown on this map is a comparatively high rental section, on the top of a knoll in East Cambridge, and around it the rentals run low. This map afforded another opportunity for studying the development of the city and of assisting the assessors in getting at a fair value.

Then we made a study of the lots and blocks in the city in order to find out what the standard size of lot might be. In Baltimore the standard depth of lot is 150 ft. In Cambridge we found that by far the greater number were 100 ft. in depth, and we therefore took this as the standard depth.

The foregoing might be called a preliminary study in order to inform ourselves — and, by the way, throughout the time these studies were going on we had frequent hearings. We had various representatives of assessing bodies come before us; we invited the real estate men of the city to come before us and give any suggestions; and throughout our work I want to say that we had the heartiest coöperation of the trustees of savings banks and the real estate men of Cambridge. The Cambridge Real Estate Exchange gave us enormous assistance in the way of suggestions in our work before we turned it over to the assessors.

When we had finished this preliminary study the question at once arose what sort of a unit we should use, for, if we were going to compare one part of the city with another, we must have a common unit with which to make the comparison. In

New York and Baltimore and the other cities which have adopted a system, the front foot, so called, is used.

I do not need to tell engineers what that is, one foot on the street and one hundred feet deep; but we in New England are not in the habit of thinking of front feet. All our sales are made on the square-foot basis, and yet we were unable to find any city that had adopted a square-foot unit. We made considerable study to see if the front-foot unit could be used in the city of Cambridge, and we decided there was no particular reason why it should be used, and that if we attempted to use the front foot, the system would not be such that it would furnish a method of conversation between the assessors and the citizens, and that is what we were working for, — some common language so that the assessors and the citizens might talk with one another and not have a citizen come in and say, " I do not believe your value is right," and have the assessor say, " We believe it is right," and simply split on opinion on these matters. So we adopted the square foot as the unit.

It is a well-known fact, that, where there are two lots side by side, one 50 ft. deep is worth more than half as much as the lot of the same shape and frontage which is 100 ft. deep. Just how much more was another problem which we had to solve. Then the proportion is not the same in the residence as in the business districts. There have been various rules for the enhancement of values of a lot due to the corner influence, — that is, the increased value of a lot because it is located at the corner of two streets. And the last thing we went to work upon was the equalization map. With regard to the standard depth of lot, it might be of interest to you to have a few figures. We have in Cambridge some 932 blocks. Of these, 74 per cent. are divided into 100-ft. lots and 26 per cent. into lots of greater or less depth.

A word more in regard to the long and short lot rule of proportional value of lots of varying depth. In 1866 Judge Hoffman in New York ruled in court that a lot 50 ft. deep was worth 66⅔ per cent. of a lot 100 ft. deep. That has been held for some time in the city of New York. In Cambridge we plotted actual sales, mortgages and capitalization of rentals on a chart on which abscissæ represent the depths of the lots and ordinates per cents. of unit values. Then we drew a curve representing the increase of values in a foot of short over long lots. We did this for the business districts and for the residential districts. We compared these curves with the ones we had obtained from New York, Buffalo and Baltimore by placing them upon another chart. Newark was one of the first cities to adopt a systematic method of assessment, and they had a good system but they never had it on a chart. When we had plotted their figures on a chart we found certain irregularities which they admitted they had not noticed until the curve representing the figures had been called to their attention. A table of comparisons was then worked out. For instance, for a depth of lot of 25 ft. the value in New York is 41.7 per cent., and in Newark it is 50 per cent. in the business and 37 per cent. in the residential district of the values for 100 ft. lots. In Cambridge the old line of assessment ran back almost straight until it got beyond 100 ft. in depth. The figures had never been plotted for Cambridge although the assessors appreciated that lots much more than 100 ft. in depth were proportionately of less value. They had not, however, worked out this curve in actual assessments. We placed these charts before the Cambridge Real Estate Exchange and asked them to criticize them. They said they thought we had made a mistake in our residence chart, that we went back too quickly in the very shallow lots. We asked them why. They could not give us any figures, and they said perhaps we were right. We found after one year's practice that the real estate men were right, though they could not convince us that we were wrong; but the actual application of the figures has shown that to us, and the curve for residence districts will be somewhat flattened in future.

Now, to illustrate the application of the depth curves to lots of various depth. Suppose we assume a lot on a street having a ten dollar per square foot unit, the lot to be 50 ft. in frontage. Obviously, under these conditions a lot 100 ft. deep containing 5 000 sq. ft. would be worth $50 000, since the 100 ft. depth is the standard, and each square foot is worth 100 per cent. of the unit. Now, suppose we find the value of a lot 75 ft. deep; we turn to our curves or long and short lot tables and we find for business sections that every square foot of a 75 ft. lot is worth 117 per cent. of the unit; thus the unit value per square foot for this lot would be $11.70, and since the lot contains 3 750 ft., the total value of the lot would be $43 875. Application of these rules for lots in residential sections is similar to the illustration just given.

In order to simplify the work for the Board of Assessors, the committee worked out a coëfficient for each of the twenty thousand odd lots in the city of Cambridge, depending on its depth, shape and location. This coefficient represents all the factors entering into the assessment of any particular lot except the unit value placed on the equalization map by the assessors. In this way it is only necessary to multiply the coefficient by the unit value to obtain the assessed value of the lot, the coefficient, of course, remaining the same until the lot is cut up.

We have also applied a method for obtaining the enhancement value of a lot because of its location at a corner. Mr. King adopted a plan, some years ago, and that was followed originally in New York. New York now treats the lot as fronting on the main street, and adds a definite percentage of increase to the value of that lot and says that is the increased value due to the side street, an arbitrary percentage throughout the city. Mr. Bernard, a special tax deputy in Baltimore, worked out a more equitable plan, we think. He found the value of the lot as if it fronted on the main street and took one half the side street value and added it to the value on the front street. That gave him relative valuation of the side and front street as to that lot. In the business district of Cambridge we found the value of the lot on the main street and value of it on the side street and added to the value on the front street twenty-five per cent. of the value on the side street, and that seemed to work out pretty well.

There are a few minor factors of value which were worked out in some places. One of them is where a particular lot is located, or a series of lots are located, upon an alley; for instance, these two lots had an alley between them. In cities where there are many alleys the increase due to the alley influence has to be worked out, but in Cambridge we do not have enough to give us data upon which to base a definite plan, and therefore we did not attempt to lay out any rule for the city. There is another factor which enters into the question of value, and that is the question of plottage. A large tract of land in a certain location is very much more valuable because of its size than it would be if cut up into smaller lots. That of itself must be taken into consideration in making assessments; but we did not, owing again to lack of information, work out any definite rule in Cambridge. We did work out an equalization plan on what is known as an "equalization" map. That was nothing more or less than a map of Cambridge with the streets laid out a little wider than they ordinarily would be, and main public buildings located all without regard to lot lines. Now, the use of this equalization map is to do away with that picture puzzle I spoke of earlier in the evening (that is, the patching together of this lot and block collection of maps), and thus give the assessors and the citizens of Cambridge an opportunity of comparing the units, one with another. Given a unit of one square foot, the problem was up to the assessors to place the value of that unit upon every side of every block in the city of Cambridge, irrespective of lot lines; irrespective of anything except the value of one square foot located on the street on every side of every block. It gives the assessors an opportunity of getting a bird's-eye view of the city, of placing the unit value at the highest point at Harvard Square and another one at Central Sauare, and then of grading values to the lowest point between these two. That in itself is of enormous value to the assessors. It gives them an opportunity of studying large districts in the city. We believe it will be of enormous assistance to the county commissioners, for most of the appeals are taken to the county commissioners in Cambridge — the assessors being Democrats and the county commissioners Republicans.

We believe that when that is presented to the county commissioners this year some of the values that have been placed by the assessors in Cambridge will not be hacked quite as badly by the county commissioners. But neither of these purposes is of the greatest value. The greatest value is that you and I as citizens can see whether our property is valued on the same basis. We may pull down these maps in the assessors' office and may argue that our land located here is valued at a certain amount and we believe it should be valued less or more. In other words, it gives us a common language in which to talk with the assessors.

Now we turn to the method of valuing buildings. In the first place we made a study of the different units of value in actual use to-day, and we decided that the cubic foot was probably the most inclusive value and was the unit we would adopt in Cambridge. We then made a study of the different kinds of buildings and divided them into sixteen different groups, — garages, single houses, double houses, three apartment, etc., and then we subdivided these groups into kinds of construction. We then worked out a table of maximum and minimum values. We consulted all the contractors, engineers and architects that we thought would give us an opinion. We turned the matter over to the Boston Society of Architects, and secured the assistance of individual members of their association, also Stone & Webster, Aberthaw Construction Company, etc., who helped us to work out a maximum and minimum value of a cubic foot for each kind of building with the different kinds of construction. Then we worked out a table for percentage of depreciation which should be applied to each one, and that was also approved by the different organizations and individuals whom I have mentioned. We turned over all this information at public hearings to the citizens of Cambridge. Throughout our activities we tried to keep in as close touch with the citizens as we could, for we knew that they were the final judges and that if they did not approve the work we were doing it would not be worth much; and we invited their criticism when we worked out these problems. We had public hearings and one man attended who did not understand exactly what the tables stood for, and he was the only one who came to that public hearing. So we felt that we were pretty nearly right.

Having completed the unit value and table of depreciation, we had every building in the city inspected and measured. We made a record of the kind of construction, the finish, the kind of plumbing, and condition of repair. All of which information appears on the card catalogue with the unit applicable to it.

We worked out also a few forms for use in the assessors' office. In the old days we had land set off by wards. We had eleven wards in Cambridge, each ward in a different book, and, in order to be sure you had covered all the land a man owned in Cambridge, you had to go over all those books. That has now been changed by the assessors' office. They have now arranged the entire record of property in Cambridge alphabetically.

It is with a good deal of pride that we say that the tax commissioner of Massachusetts issued a pamphlet of instruction to assessors some months ago, and in that little pamphlet, copies of which I have here, is a brief description of the Cambridge system of real estate assessment. The interest in this system from outside, as the President has said, has been very great. We have had inquiries from many places, and to-day I received one from Greensboro, N. C. We had one from the appraiser of the Interstate Commerce Commission in Minnesota, and from a large number of cities and towns in New England.

That constitutes the machinery. Now perhaps you would like to have a word in regard to its application in the city of Cambridge. As soon as we turned this matter over to the assessors, the first piece of work for them to do was to take the equalization maps and place upon them the tentative values of the unit. That was a considerable piece of work. They did that throughout the city, and then we went about from one district to another throughout the city. I am sure it is the first time in New England, and I think it is the first time including most other cities and towns, that the assessors have asked the assistance of citizens in fixing a fair value of property. Having placed these tentative values, hearings were given throughout the city, and the citizens came in. In one district, the one in which I live, they were there in force. They thought the whole thing was all wrong, and the assessors did not know what they were doing. The unit was too high throughout the district. We asked them how about the comparison of values. They had not looked at that. We asked them how land on the main street compared with land on the streets leading off of them, and they said about one hundred dollars to eighty dollars, etc. They looked and found that the assessors had so placed them; and they found that throughout that district, except in one or two instances, the relative values of the unit had been very carefully placed and were not subject to criticism. When they found that the particular lot they owned was not being gouged, and that they were not being made goats of in this proceeding, most of them decided that the method was pretty fair. The amount of assistance that the assessors obtained from these hearings was enormous. We had stenographers present. One man would say that the unit value on his street was too high, and the chairman would ask him how it compared with the same piece on the next street, and he would express an opinion, without consulting the tentative value on the map, and in most instances we found the assessors were pretty nearly right. There were some cases where changes were made, but that the assessors were looking for. They appreciated that and made the most of it. Then, having all that information, they worked out their final assessments, and the bills came out in October and November. In November we held a municipal election. The chairman of the board was running for reëlection. He was opposed by an ex-assessor who was a member of the board of aldermen, a very popular vote-getter, and the attack was on the Cambridge system. The chairman of the board was reëlected by over two thousand majority, which is a good majority in the city of Cambridge in these days. That was immediately after the bills were out.

Now, a word or two on the dollars and cents. In 1916, the total assessed value of land alone in the city was $45 135 700. In 1917 this jumped $7 704 700, to $52 840 400. The value of buildings in 1916 was $63 133 000 and in 1917 this increased $304 000, to $63 437 000, a total increase of over $8 000 000. That is not all due to the adoption of this system. Comparing that increase with the average of the years 1912, 1913 and 1914, — and I take these three years because from the year 1914, when we began working on this system, the assessors did not put on the ordinary increase in real estate, — the average increase was practically one and a half million dollars. The average increase in buildings in those three years was over two million dollars, a total of three and a half millions against an increase of eight millions; and I am told by the assessors that there was just about as much increase in building in the year 1917 in Cambridge as there had been in those three years. In other words, the result of the application of this unit to the buildings in Cambridge was greatly to reduce their value. It may be of interest to you to show the result of studies of the relative values of land. Take an industrial block in East Cambridge. In that particular block there were 13 lots. All of these 13 lots show an increase. The maximum on one lot is 100 per cent. and the minimum increase, one lot, of 20 per cent. In another poor-class residential block but with good demand, there were 58 lots. One shows a reduction in value of 25 per cent.; 13 remain the same as before; and 34 lots are above in value. A business block in Central Square having 27 lots has 6 which are below the valuation of the year before and 21 above. The greatest is 12 per cent. below, and the greatest increase is in a little bit of a lot which really is not worth considering, where it is over 200 per cent. increase; but that is a little bit of a lot which had been overlooked in a previous reassessment and is, I think, the only lot which has an increase of anywhere near that percentage in the city. Then in a block containing dormitories changing over to apartments in Harvard Square, there are 35 lots; 22 show a lower valuation in 1917. The minimum is one tenth of one per cent. and 13 are increased in value, the maximum being 26 per cent. Another industrial block, on both sides of a railroad, has 18 lots, all of increased value, the maximum being 96 per cent. and the minimum $3\frac{1}{2}$ per cent. That gives you an idea of how valuations change when you place a systematic plan in operation.

DISCUSSION.

Mr. James J. Casey.* — I came here to-night upon the invitation of Mr. Hastings, engineer for the city of Cambridge, to listen, rather than to talk, as I wanted to hear our system discussed by the members of this Society. I am glad, however, to give to the meeting the benefit of our experience with the system.

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* Chairman, Board of Assessors of Cambridge, Mass.

As it happens in most instances where a change is made from one system to another, even though the study and preparation cover a period of years, when the time arrives to put the change into operation there is much haste and confusion. Therefore due care cannot always be given to every detail which would make for a complete and correct revision of real estate values. Moreover, we were rather unfortunate in the year that the system was installed; war times were upon us; money was scarce, and it was difficult to maintain values. It was late when the tax bills were sent out, and because of this delay and the previous discussion of units, which were not always understood, there was more or less unrest in the minds of the taxpayers. When the people finally learned the result of our work and it was explained to them, they were, generally speaking, satisfied that we had accomplished what we had set out to do — that is, to equalize values, and that the assessment for 1917 was nearer correct than ever before. Please bear in mind that the object of the system is not to raise values but to equalize them.

We had, however, an increase in land values over 1916 of about seven and three-fourths millions of dollars, or 17 per cent.; a substantial increase for Cambridge. The area of the city is only six and three-fourths square miles, with one and one-half square miles of this area exempted from taxation and another square mile unfilled low land.

The main criticism of our new assessments was of the units, not of the system. During the abatement season, many taxpayers whose land had been assessed higher than in former years came in to learn the reason why. We very carefully explained to them the plan under which we were working; compared their land with other land in the vicinity; showed them that all owners must be treated alike or the system would be worthless, and that equalization of the burden of taxation was our aim. I am glad to say that in the great majority of cases they went away satisfied that all were receiving the same treatment, admitting that their land was worth our assessed value.

Of course we do not claim perfection for our work in the first year; but we do promise better results from year to year, and hope to have it perfected within three or four years. In New York, where they have a similar system, it took about eight years to become readjusted to the change.

I think there should be a change in our table of percentages of relative value affecting short lots. In my opinion, this class of lots carries too high a percentage of the standard lot, particularly in the residential sections of the city.

Unfortunately there was not sufficient time to review the new building values. Our table of units of reproduction and allowance for depreciation was substantially correct, but the buildings were not always put in their proper class. This condition was not very serious and was comparatively easy to rectify.

Our office was fortunate in the possession of accurate block maps upon which lot lines were drawn to scale. These block maps are corrected and kept up to date by the city engineer, from tracings of plans of lot subdivisions filed at the Registry of Deeds.

For many years the assessors of Cambridge have asked the city government for money for equalization maps, but with no success. The special tax commission immediately saw their necessity and provided them.

Having the necessary tools, we then placed a unit of land value in every street, as shown on the maps. This was obviously the important feature of our work. A coefficient had previously been worked out for each lot in the city. To get the value of any lot, the coefficient is multiplied by the unit. These coefficients have a degree of permanency and remain the same until the lot lines are changed. The unit of value is always a more or less varying figure. Should it be changed it would be a simple matter for the office clerks to multiply the coefficient by the unit to get the value of the lot affected.

We have in our files a complete history of every building in the city. This information was gathered by men who were sent out to measure the buildings so that the cubic contents might be computed. The same men again went out to note the class to which the building belonged; its construction, its age, its use, the number of rooms, how finished on the exterior and interior, its condition, rentals, and the condition of the street. From this information we were able to apply the unit per cubic foot for reproduction: also the depreciation to be allowed. This data is not only invaluable to the assessors, but to the public, because of its availability.

This yellow card (Figs. 1 and 2) is a sample of our office cards, and is reproduced on page 44 of the pamphlet issued by the tax commissioner. Upon this card is entered, on one side, the area, coefficient, unit and value of the particular lot of which it is a record; also all information pertaining to the building, cost of reproduction, depreciation and value, for assessment purposes. On the other side is written the location of the property, the name of owner, value of the land, value of the building and the total value. From this, our tax list is written as well as the book that is sent to the tax commissioner.

With regard to the coefficient used, where there are restrictions I would say that the coefficient is determined in every instance by the application of our table of percentages of relative value to the depth of the lot, and remains unchanged regardless of restrictions. Allowance for restrictions is made in the unit. The assessors do not always have knowledge of restrictions. The public meetings that were held to discuss land values aided us in learning about streets so affected.

Our coefficients were computed by competent men in the employ of the commission. These computations were made in books provided for that purpose, and are a part of our office records.

The assessors are able to make any changes that might happen from time to time. This is the advantage of the Cambridge system. There is no secret formula for the working out of any problem, and every feature of the plan is easily understood and readily applied.

Mr. Albert B. Fales.* — Mr. Bell mentioned the fact that in sending out a little pamphlet of general instructions to the assessors throughout the Commonwealth, in 1917, the tax commissioner's department took occasion to review in a very

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* First Assistant Tax Commissioner of Massachusetts.

HOUSE NO.	NAME OF STREET	DIST. No.	BLOCK	LOT	RESTRICTIONS
206	*Cambridge*		*12*	*8*	*None*

BLDG. CONSTR. OR MOVED ON LOT IN 1905 PERMIT No.

RENT, ETC. *Occupied by owner*

REMODELED, REPAIRED, ETC. *Original condition*

GROUND AREA	HEIGHT	CUBIC FEET	CLASS.	UNIT	DEP. %
40 × 25	*28*	*28000*	*S. H.*	*.18*	*1½*

CORNER *No.*

ALLEY *No.*

PLOTTAGE *50 × 80 Rectangle*

COMPUTATIONS

50 × 1.08 × 4000 = 2160
40 × 25 × 28 = 28000
.18
5040.00

AREA	MULTIPLIER	K
4000	*1.08*	*54*

	LAND			BUILDING		
YEAR	UNIT	K	LAND VAL.	DEP.	AMT.	BLD. VAL.
1915	*.50*	*.54*	*2100*	*.15*	*750*	*4284*
1916	*.50*	*.54*	*2100*	*.105*	*832*	*4208*
1917						
1918						
1919						
1920						
1921						
1922						
1923						
1924						

Class
Bungalow
—Single House
Two Family
Three Family
Apartment
Store Building
Office ,,
Factory ,,
Storage ,,
Stables
Garage, Private
Garage, Public
Theatre
Club House
Miscellaneous

Foundation
—Brick
Stone
Concrete
Pile

Basement
—Full
Half
Quarter
Cement Floor
Waterproof

Construction
—Frame
Brick
Tile
Blocks
Stucco
Re-Concrete
Mill
Semi-Mill
Steel Frame

Exterior
Clapboards
Siding
—Shingles
Stucco
Paper
Press Brick
Com. Brick
Galv. Iron
Stone
Terra Cotta
Concrete

Heating
Stove
—Furnace
Hot Water
Steam
Combination
Sprinkler

Light
Oil
—Gas
Electric
Acetylene

Plumbing
Common
Individual
Open
—Set Tubs

Floor
Common
Re-Concrete
Concrete Slab
Mill
Bay
Thick
Waterproof
Finish

Ceiling

Finish
Plain
—Hardwood
Halls
—Wood
Terrazzo
Marble

Roof
—Shingle
Slate
Tile
Gravel
Prepared
Asbestos
Metal

Flat
—Hip
Gable
Gambrel
Dormers

Windows
—Plain Glass
Wire Glass
Shutters

Miscellaneous
Elevator
Sprinkler
Fire Escape
Refrigerator
Vacuum Cleaner
Safes and Vaults
Telephone Equip.

FIG. 1

WARD
PR.
LOCATION *206 Cambridge St.* RES. NON-RES.
BLK. *12*
LOT *8*

YEAR		DESCRIPTION	Bld. Val.	Sq. Ft.	Land Val.	Total Val.
1915	*William H. Smith* *206 Cambridge St.*	*Single Dwelling*	4284	4000	2160	6444
1916			4208		2160	6368
1917						
1918						
1919						
1920						
1921						
1922						
1923						
1924						

Fig 2.

brief way, as was necessary in such a document, and in terms which would be readily understood by the average man, — and the assessors throughout the Commonwealth, generally speaking, are average men of the town, — the principles underlying the Cambridge system. That was done with the hope of encouraging the assessment of real estate by a system which would afford a means of comparison between different parcels of land better than the old rule of thumb or guesswork. It is perfectly true that in a small town the board of assessors, composed of good average men of the town, can go out and view the parcels of real estate and value them quite accurately, — almost with surprising accuracy, simply from their general knowledge of the values in the town. They know every sale, and they know every mortgage, and they know all the gossip of the neighborhood. They know the soil and the farms and about everything that is to be known about those properties, and they do reach very close values in that way. But when you get into the cities, and particularly our larger cities in Massachusetts, that rule of thumb falls down. In the first place, as your city grows it becomes impossible for three or any other number of assessors to visit all the real estate together so as to give their judgment as a body on each parcel of real estate. The first thing that happens is that the board of assessors divides the work into as nearly equal parts as possible among the three men, and each man goes out and views a separate territory. Your troubles just at that point begin to magnify. One member of the board is an optimist, and everything looks good to him, and all his real estate is valued up pretty well. The other man by temperament is a pessimist, and nothing looks good to him, and his values are very low. Equalization drops out of the thing right at that point. And then as the size of the city grows the difficulty increases. I feel very strongly, and I am willing to say it in the presence of some members of the Boston assessing department who are here this evening, that Boston is very much in need of a system of real estate valuation. As a matter of practical working, fifty men in Boston go out in fifty different districts and work with very little regard each to what the other is doing, and the result of such work does not tend to uniformity.

There ought to be a system by which the board of assessors could keep under its control what is to be done in the various districts by the various men that handle those districts. And it has been a matter of great satisfaction to the tax commissioner's office that the city of Cambridge waked up to this necessity and took the matter in hand. We feel that they have done an excellent piece of work; that the committee of which Mr. Bell was chairman has accomplished the laying of the foundation of a system of taxation which is applicable in Massachusetts better than the systems that are in use in other states in the Union, chiefly for the reason that all of their tables and curve values are made on the square foot basis. Of course here in Massachusetts we buy and sell and discuss real estate by the square foot, and the average citizen does not know much about what you mean when you attempt to tell him that certain land on a certain street here in Boston is worth ten thousand dollars a front foot. Now, as a matter of fact, the front foot rule does not mean anything taken the country over. In New York it means one foot on the street and one hundred feet deep, because that is the way they figure in New York. In Baltimore it means one foot on the street by one hundred feet deep, and in some of our western states it means one foot on the street by one hundred twenty-five feet deep. We have to know the city we are talking about before we know what a front foot means; but here in Massachusetts we all know what a square foot means, and all the computations for the city of Cambridge are made on the square foot basis. I consider that very much better for Massachusetts use.

MR. FRANK O. WHITNEY.* — I have been very much interested in the description of the work of the assessors in Cambridge. I have not heard very much said about the making of the plans. It seems to me that no system can be practically applied without a reasonably accurate plan to start with. You can assess by the square foot after you know how many square feet there are, but not until then. You cannot assess by the cubic contents of the buildings unless you know the size of the buildings. I do not know whether in Cambridge they had an accurate plan, or reasonably so, before they started. My experience has been entirely in the city of Boston, and I have been surprised in the number of years that I have had more or less to do with the assessing department of the city, — using their records a great deal, — to find how good their work was considering the fact that they did not have a comprehensive plan to start with. In some cities like Philadelphia and, I think, New York, — and I presume Baltimore, — they have complete block plans which show dimensions and areas of every lot from actual survey, and the buildings plotted to scale. In Boston it has been the custom, I think, of the assessors to watch carefully the registry of deeds. When plans have been made of individual lots they have had access to them and have made copies of them; and in cases where owners thought they were not being correctly assessed, especially where they thought they were being over-assessed, they have had plans made of their own property, and the assessors have been always ready to accept these plans when made by reputable surveyors. But, so far as I know, the assessing department of Boston has been handicapped by not having a complete plan of all the property in the city, and for that reason a great many errors have been perpetuated and a great many errors were originally made, because there was not that accurate foundation. In the old days they were not so careful in making deeds as they are to-day. I have known cases — for instance, in Hull Street in the North End — where deeds gave the depth of the lot as 100 ft. and the transfers down to the present time had simply recited that fact, whereas measurements showed that the lot instead of being 100 ft. deep was about 94 ft. deep. There was a case of over-assessment if the square foot was regarded. Boston has been made up by the annexation of a number of other municipalities, and errors which existed in the old times in those places have naturally been perpetuated, and sometimes errors have crept in on account of changes that took place about the time of annexation. I remember one case that came to my attention in 1895, in Roxbury. In 1868 Roxbury was annexed to Boston. In 1867 Longwood Avenue was extended to Brookline Avenue. Included in that extension was a certain piece of land fifty feet wide and one hundred feet deep. It was late in the history of Roxbury, and the

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* Chief Engineer, Street Laying-Out Department, City of Boston, Mass.

Roxbury assessors turned over the records to the Boston assessors, without correction, and the change was lost sight of. The owner made no objection, and until 1895 that piece of land was taxed to the prior owner. It was an estate in the hands of heirs, and when they wanted to sell the property they found they owned five thousand feet less than they had supposed. Of course there was no redress, — they had paid taxes for nearly thirty years, and it was as much the owner's fault as the assessors'. There have come to our attention many cases where untaxable property has become taxable property. Take, for instance, right here in the heart of the city, the block bounded by Washington, Summer, Chauncy and Avon streets, where the Jordan Marsh and Shuman properties are located. His honor the mayor requested our department to make a survey of that block to test whether much that had been said in regard to the areas in the business district was correct. We found in that block, on account of passageways which existed when the block consisted of a large number of smaller estates and which were afterward consolidated and the passageways covered up, that these passageways had not been assessed. We found eight hundred feet more land in that block than had been assessed. At one hundred dollars a foot, that was eighty thousand dollars' value, which would have meant perhaps, at the rate of taxation at the time, fifteen or sixteen hundred dollars a year loss in taxes. Some people have thought that enough such land would be found in Boston to pay for a complete survey. I do not agree with them, because I think that while there would be places where there might be a considerable amount found in excess of what is being taxed, I know that in many cases more land is taxed than exists. I think probably in a survey of our business district there would be discovered more land than is being taxed, but not enough to pay for the survey. But I would not depreciate the value of a survey on that account. I think it is only due to the assessors of any city that the city should give them an accurate plan on which to work and not expect them to pick up here and there the information that is necessary in order for them to do such important work as the assessing in a large city involves. Some years ago we discovered a case where the city owned a small piece of land on Washington Street, in the Northampton Street district. We had to raise the grade for sanitary reasons, and the land was all surveyed with the idea that the city might later take it over and reconvey it. At that time the Metropolitan Railway Company had a car stable on Washington Street just beyond Lenox Street. It was formerly city land, as was all the land up in that region. We found in the survey that under that car stable was a strip of land ten feet wide and one hundred feet deep which the city had never conveyed but over which the Metropolitan Railway had built this stable and had continued the use of that land for nineteen years. It so happened that the twenty years which would prevent the city from dispossessing them had nearly expired, so the railway company was notified that the city owned a piece of land there, and they were asked to come around and settle. The firm which represented the Metropolitan Railway at that time was Gaston, Field and Jewell. Mr. Jewell came into our office very much incensed that anybody should accuse his firm, and especially his client, of having stolen any land. We gave him our reasons for claiming the land belonged to the city, with the result that he came around again some time afterward with a check for one thousand dollars. The city accepted that, and gave the company a title to the property. When the South Station was built, a large part of the property on which it was located was docks and wharves. There was a large excess down there which had escaped taxation — I presume partly on account of being dock property not having been considered especially valuable. The largest error that I know of, so far as the number of square feet is concerned, was a case out in Brighton. When Brighton was annexed to Boston it was largely a farming community. There was a piece of land, about six or seven acres, situated on the corner of Brighton and Harvard avenues, belonging to the Herrick estate. It turned out, when the land was surveyed after it came over into Boston, that there was a discrepancy of over ninety thousand feet of land, — over two acres. For the reasons I have mentioned there seem to have been a great many errors, and my appeal to-night is that the assessors of Boston and the assessors of every

TABLE 1. — DETAILS OF SOME CASES INVESTIGATED BY THE STREET LAYING-OUT DEPARTMENT OF THE CITY OF BOSTON WHERE ACTUAL SURVEYS SHOWED AREAS IN EXCESS OF THOSE USED BY THE ASSESSORS.

Location.	Year	Assessor's Square Ft.	Survey Square Ft.	Excess Square Ft.
Commonwealth Ave., Brighton, Ebenezer Francis Estate	1897	150 000	155 089	5 089
Commonwealth Ave. and Brighton Ave., Ebenezer Francis Estate	1897	174 014	182 179	8 165
Brighton Ave., corner Harvard Ave., Emily Herrick	1897	135 418	227 000	91 582
Brighton Ave. and Linden St., Isaac Pratt Estate	1897	5 286	6 063	777
Cambridge St., Bowdoin Sq. and Green St., Nos. 28 and 30	1898	16 050	18 880	2 830
Green St., Nos. 28 and 30	1898	2 700	3 300	600
Staniford Place	1898	800	1 217½	417½
Brighton St., Nos. 111 and 113	1898	2 400	2 700	300
North St., corner Cross St.	1898	1 700	2 450	750
Medford St., corner Short St., Charlestown	1898	2 500	3 821	1 321
Federal St., Hobbs Wharf	1898	78 515	83 470	4 955
Federal St., Wales Wharf	1898	67 097	70 650	3 533
Federal St., Francis Wharf	1898	91 702	93 546	1 844
Federal St., Curtis and Drake's Wharf	1898	195 260	201 835	6 575
Federal St., Piper's Wharf	1898	75 008	75 689	681
Federal St., Richardson's Wharf	1898	119 383	134 133	14 753
Atlantic Ave., Nos. 183–197	1910	11 352	13 334	1 982
Norfolk St., Dorchester, Sophia L. Door	1912	253 473	272 015	18 542
Monument Sq., Charlestown, estate of Patrick O'Riorden	1912	*	†1 600	1 600
Summer St., corner High St., Moses Williams et al.	1913	2 837	3 051	684
Washington, Avon, Chauncy and Summer Sts.	1914	‡	‡	811
Tremont and Hollis Sts.	1914	‡	‡	1 379
Hawley Place, near Arch St.	1917	1 670	2 735	1 065

* Not assessed. † Approximately. ‡ Total figures not given.

city in New England have placed at their disposal a correct map of the territory which they are to assess, if it is to be assessed by the square foot. The latest case brought to our attention was one of a passageway on a semi-private street, where there was a piece of property which was rather under-assessed, and the amount that it was really under-assessed was really in the passageway, and there was a good deal said about it in the papers; but I think it is a good deal of a question whether it should have been assessed or not. At any rate, it was not, although the Finance Commission and the newspapers talked about it and the counsel for the property said it did not make any difference how much the block contained, as the property was worth so much, and if you called it worth forty thousand dollars and there were three thousand square feet in it, it did not make any difference whether the property was assessed in regard to the passageway or not. But it seems to me it is a good plan to have a correct plan and give all the details that are necessary, and if we are going to tax by the square foot let us know how many square feet we have to tax.

Table I gives the details of some of the many cases which have been investigated by our department.

E. O. Christiansen.* — The important consideration which I would like to emphasize in this discussion of the Cambridge System for the assessment of real estate, is the futility of attempting equitable taxation without equitable assessment, and as a corollary the impossibility of equitable assessment unless based on the foundation of an orderly scientific plan. The necessity for a fair apportionment in the burden of taxation is becoming more and more evident with the increase in the cost of government and the consequent necessity for raising the rates of taxation. The difficulties pointed out in the discussions by Mr. Fales and Mr. Whitney, which confront the assessors working under the rule of thumb methods, make it practically out of the question for them to place just and fair values on property. In other words, if an assessment system is dependent on a matter of personnel, or if the system was developed to suit conditions which no longer exist, the result is invariably evasion or the shifting of the tax burden.

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* Formerly Engineer for the Tax Committee of Cambridge, Mass.

At best, individual judgment is a dangerous basis of valuation, and, under a system which allows such rough guess or calculation, it is impossible to avoid error in particular cases. The results of such methods are "liberal" assessments and dissatisfied tax payers. Careful investigations have shown that the large majority of errors in valuation are made to the disadvantage of the city treasury. It has been proven, in every instance where a scientific plan of assessment has been introduced, that the undesirable features of the rule of thumb methods disappear. The scientific plan must of course be adjusted to local conditions.

There are certain advantages of vital importance which accrue from the use of a scientific plan. In the first place, the values which result from its use are not haphazard, but are based on definite and constant economic laws. It also gives the board of assessors an opportunity to obtain a general or bird's-eye view of the city as a whole, and enables them to see clearly relative values of land in various sections and determine the relative values of various types of structures. It does away, to a large extent, with the human equation in the value of real estate. It furnishes a common language for discussion between the tax payer and the assessors. The plan also makes it possible for the board of assessors to convince the tax payer that he is being fairly treated and that he is only paying his relative proportion of the taxes. For this reason particularly, such a plan will satisfy business interests in the community in that all a business man wishes to be guaranteed is that his property is taxed no more than others of a like nature. Lastly, the system also provides for a constant flow of information into the assessor's office by means of which the department is in a position to follow closely the changes in developments of the various sections of the city. Coupled with close coöperation between the assessors and other departments of the city government, publicity and businesslike methods, such a plan should eliminate most of the difficulties which we are laboring under with the present unscientific and troublesome method of real estate valuation for tax purposes.

Mr. Bell.*—The question has been asked concerning the application of our system to a street like State Street in Boston, between Washington Street and Merchants Row, where every lot is of a different size and shape.

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* Author's closure.

It would be a very simple matter to place a unit on State Street. Take a specimen block of the city of Cambridge. There are no two lots in the block that are the same. The unit on this street is 30 cents. One lot is 100 ft. deep and 50 ft. wide, — and with a 30-cent value $1 500 is its value. Another lot is 113 ft. deep and 55 ft. wide. Apply this same unit and its value is $1 753. The fact that the lots are irregular makes no difference in the valuation of the unit. That is merely for the basis of the assessment. It does not make any difference what sort of development you have, speaking broadly, provided it has the average development of the district. There is no especial consideration to be given for development, as to the value of the unit on that street. In other words, you neglect your lot lines. You fix your unit on the value of one square foot on the street. Then given this, you apply it to the area of the particular lot and get the value of the lot. It sounds complicated, but if you think of it in a perfectly regular lot such as one 100 ft. deep by 50 ft. wide, and 30 cents to the unit, it is perfectly easy to see that the total value is $1 500.

One of the simplest things in the whole system is the application of the plan to irregular lots. It is perfectly easy, once you have the tables laid out, to apply them to lots of any shape; and further than that, as Mr. Fales has just suggested, that is where the application of a plan of this sort gives a good deal more certainty to assessments than does the rule of thumb that the assessors have been using in New England. There is no question but what property which is assessed under a system gets a good deal fairer treatment at the hands of the assessors than does property where the assessor goes in and says he thinks the land is worth so much money. The owner says it is worth a different amount. They do not get together because it is merely an expression of opinion on one side as opposed to an expression of opinion on the other side. In this case the individual citizen may apply these rules to his own particular lot, and may see whether they are properly plotted. He may see whether the proper coefficient is obtained, and if not have it corrected, and then, having established the fact that he has, he may apply that to his lot. If he has anything to say with regard to how that is worked out he can talk it over with the assessors and point out perhaps that it is founded on a wrong curve, just as the real estate men in Cambridge demonstrated to us.

The original induction of this system cost about $11 000 in addition to what was paid the assessors.

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PAPERS AND DISCUSSIONS

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NEWTON, MASS., WATER-WORKS RESERVOIR.

By Edwin H. Rogers,* Member Boston Society of Civil Engineers.

The covered water-works reservoir of the Newton water-supply system, as designed by the city engineering department of Newton and constructed under its supervision, is now completed and comprises four rectangular sections with a circular gate chamber at the center, in which are installed a steel distributing tank and pipes from the force main to the different sections and the overflow pipes and drains for emptying the several sections.

Section 1 is the southeasterly section, and was built in 1890; Section 2, the southwesterly section, built in 1901; and Sections 3 and 4 the northwesterly and northeasterly sections respectively, built in 1916 and 1917.

The dimensions of the different sections vary from 127 ft. in width to 174 ft. and 165 ft. in length for Sections 1 and 2, to 129 ft. in width by 214 ft. and 206 ft. in length for Sections 3 and 4. The full depth of water is 15 ft., and at this depth the total capacity of the four sections is about 10 400 000 gals., the different sections containing from about 2 200 000 gals. to 3 000 000 gals. each.

Note. This paper will not be presented at a meeting of the Society, but discussion is invited, to be received by W. L. Butcher, Editor, 715 Tremont Temple, Boston, before November 10, for publication in a subsequent issue of the Journal.

* City Engineer, Newton, Mass.

The type of construction of Sections 1 and 2 is nearly similar, whereas the design adopted for Sections 3 and 4 is radically different. Sections 1 and 2 are built with random rubble masonry gravity walls, extending some three feet below the floor of the reservoir, the roof of these sections being supported by brick columns on rubble masonry foundations below the floor. The roof of Section 1 consists of cylindrical arches supported by other arches at right angles, springing from column to column, and the roof of Section 2 is reinforced concrete flat slab construction supported by longitudinal steel I-beams. All of the sections have the roof covered with loam from 18 ins. to 2 ft. in thickness.

DESCRIPTION OF SECTIONS 3 AND 4.

Sections 3 and 4 (Fig. 1.) are built of concrete throughout, the exterior and dividing walls being 2 ft. to 2½ ft. thick at the top and 4 ft. thick at the bottom, and the walls as well as the columns are constructed on and rest directly on the floor, which is a concrete slab 12 ins. thick under the walls and a short distance inside, and 8 ins. thick under the rest of the structure. The exterior walls are reinforced by ¾-in. square bars 18 ins. on centers, so as to act as beams to resist the earth pressure of the embankments, the overturning moment being resisted by the roof, and the floor under the walls is reinforced at the corners. The dividing wall between the two sections is reinforced on each side by ¾-in. square bars placed 12 ins. on centers to resist the bending moment caused by water pressure when one of the sections is full and the other is empty, the wall being prevented from overturning by the roof acting as a strut. The wall reinforcement extends slightly into the haunches of the roof arches. The floor under the columns is reinforced by a grillage of ¾-in. square bars, thus distributing the load on the columns in such a manner as not to exceed a suitable pressure per square foot on the supporting soil. The floor was further reinforced by 6-in. by 6-in. galvanized Clinton wire cloth, lapped at all joints, to distribute temperature stresses occasioned during construction. The floor is level, at grade 305.27, Boston City Base. The floor is depressed longitudinally through the center bays in each

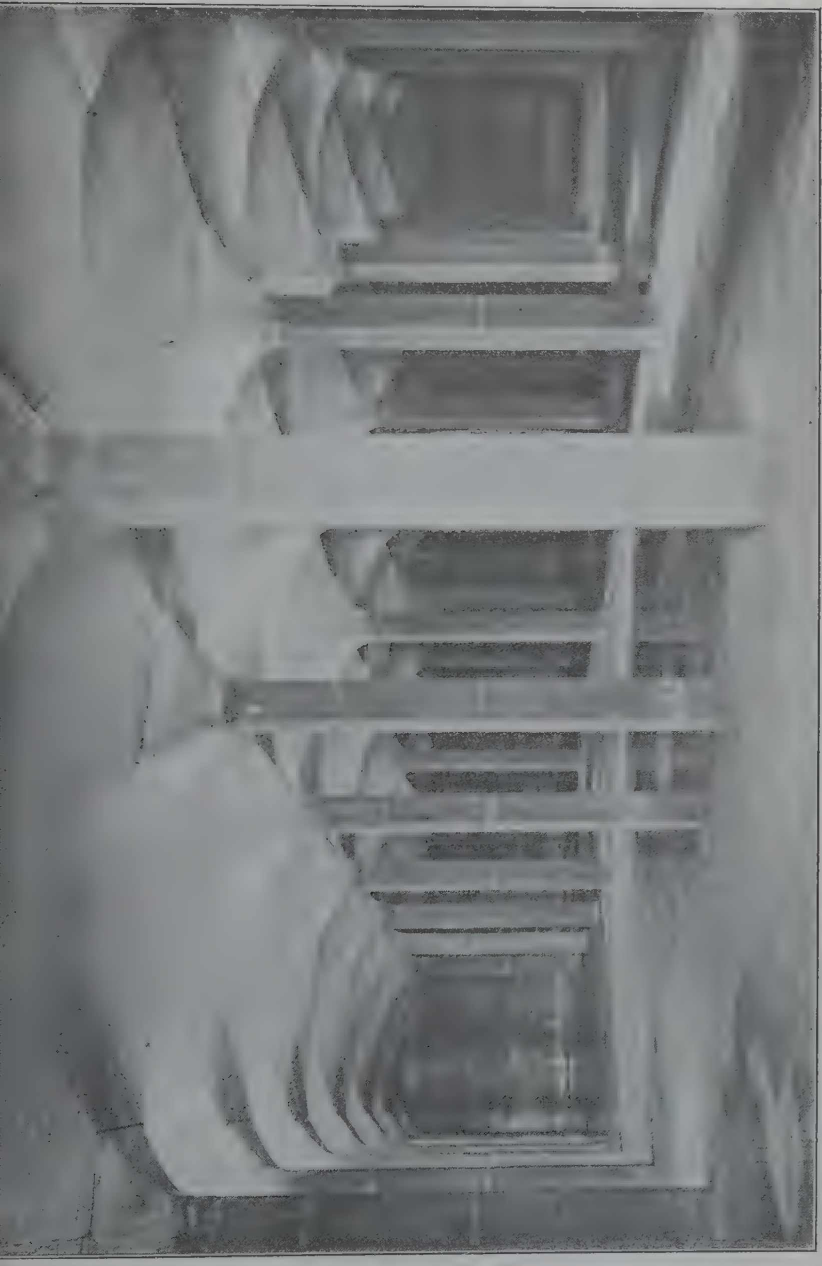

FIG. 1. WABAN HILL COVERED RESERVOIR. Interior of Section 4.

section, so as to form a gutter 2 ft. wide at its invert, with sloping sides and having a pitch of about 5 ins. per 100 ft. to the drainage outlet pipes. These gutters are to assist in cleaning the reservoir as required.

The roof (Fig. 2 and Fig. 3) is of groined arch construction without reinforcement, the intrados being semi-elliptic with a rise of 3 ft., the extrados being parabolic with a drop of 9 ins. over the columns, the thickness of the arch at the crown being 6 ins. The span of the arches is 13 ft. 1 in. in each direction.

The 16-in. by 16-in. concrete columns are without reinforcement except for $\frac{3}{4}$-in. dowels at their bases, connecting them to the floor, and $\frac{5}{8}$-in. pintles at their tops running into the haunches of the arches, and are spaced 14 ft. 5 ins. on centers each way.

The walls are reinforced longitudinally sufficiently to prevent cracking between the expansion joints, which were inserted at intervals of from 30 ft. to 35 ft. These expansion joints are provided with a folded sheet-lead dam to prevent leakage, and a sheet-steel dam is provided between walls and the floor for the same purpose.

Circular cast-iron ventilators 18 ins. in diameter and extending 12 ins. above the loam surface, with narrow slits in their sides, are provided in the roof, and one cast-iron manhole in each section provides access for inspection and cleaning.

The 24-in. cast-iron inlet pipes enter the sections from the central gate chamber at the flow line, continue of cast iron on a 45-degree slant to the floor, and are extended along the floor of vitrified pipe construction embedded solidly in a concrete base. The flow line is at grade 320.27.

The 24-in. outlet pipes are beneath the floor and located close to the central gate chamber. The drainage pipes to be used in cleaning the reservoir are 12 ins. in diameter.

The sections are covered with filling and loam 18 ins. in thickness over the crowns of the arches, and embankments on a 2 to 1 slope are built adjoining the outside walls and covered with 12 ins. of loam. The excavation for the site of these sections was done largely with a steam shovel and horse-drawn dump carts, the material excavated from the site providing the greater

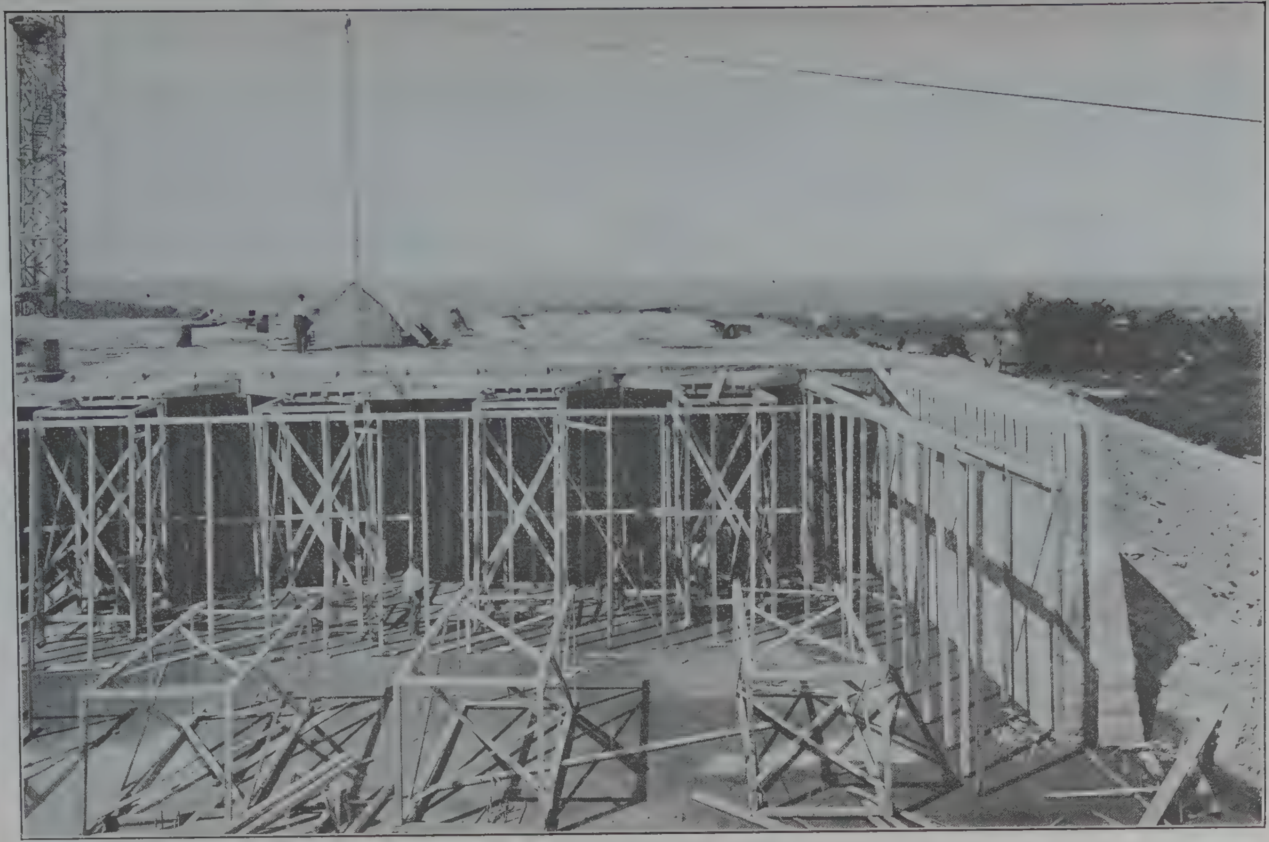

Fig. 2. Waban Hill Covered Reservoir. June 28, 1917. Roof 60% completed on Section 4.

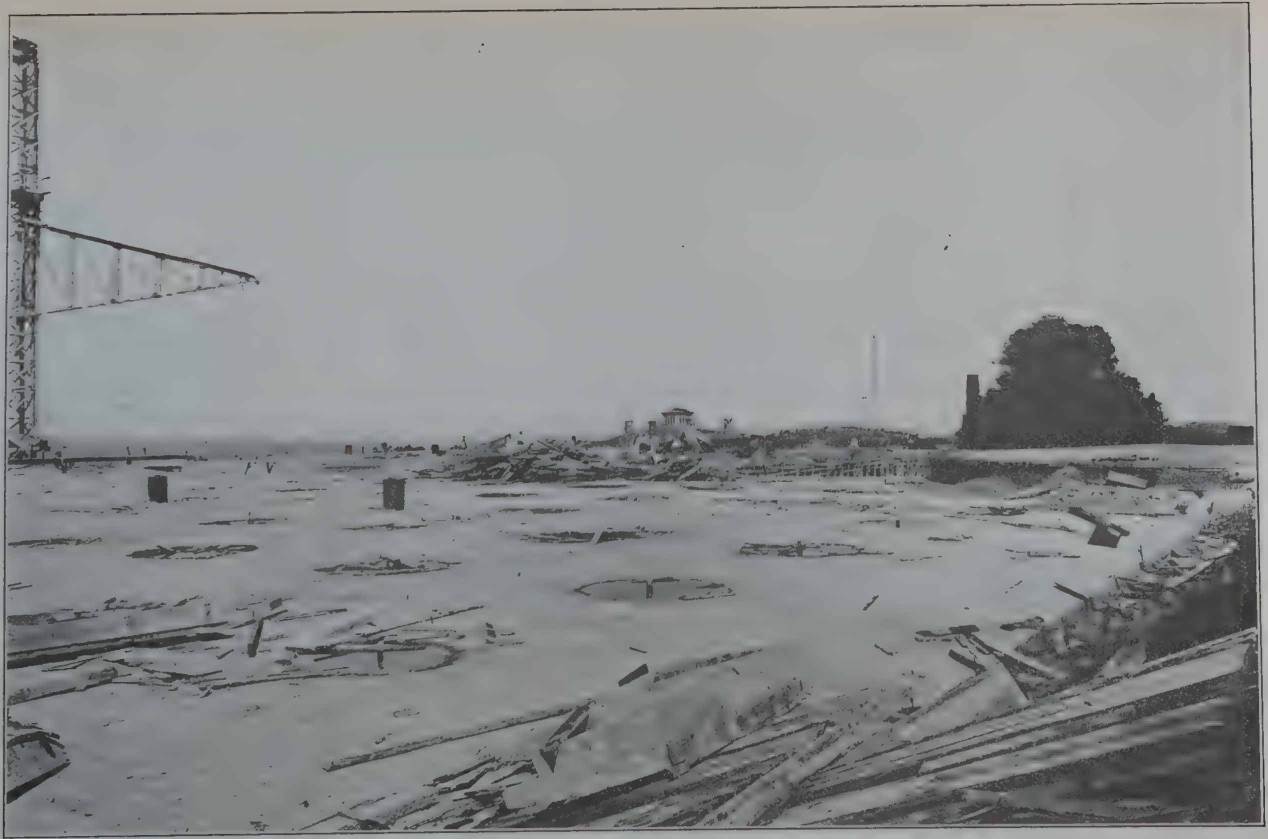

FIG. 3. WABAN HILL COVERED RESERVOIR. June 28, 1917. Roof completed on Section 3, and partly done on Section 4.

portion of the filling and loam required. The material on which the reservoir is constructed consists of what is locally known as hardpan, i. e., an intimate mixture of clay and gravel, muddy when wet but hard and dense when dry, and of such a nature as to provide an excellent foundation.

The construction plant consisted of a wooden tower over 100 ft. in height, erected on the northerly side of Sections 3 and 4, opposite the retaining wall between them, with the concrete mixer at its base and bins for the storage of the sand and stone on the northerly side of Section 3, whence the aggregate was conveyed to the mixer by an industrial railway operated by a cable from the stationary engine which furnished power for the mixer and the elevator in the tower. Chutes from the tower in several sections were provided of lengths sufficient to reach to any part of the work and were used for placing most of the floor and walls. These chutes were difficult of operation unless a large percentage of water was used in the concrete, and so their use was abandoned for the placing of the columns and roof work, in which a drier mixture of concrete was advisable than used in the floor and walls.

The concrete for the columns and roof was dumped from the tower directly into steel concrete barrows or buggies and pushed by the workmen where required.

Wooden forms were used for the walls, steel forms for the columns and the capitals of the columns part way up the arches, and wooden forms for the balance of the groined arches, the latter forms being supported by wooden posts from the floor. The steel forms proved very suitable for the straight portion of the columns, but the flaring portion of the steel forms was not all that could be desired, as they were designed without sufficient stiffening and bulged with the weight of the concrete. This bulging and the difficulty of making a smooth joint at the junction of these steel forms with the wooden forms forming the balance of the arch caused the arches to be more or less irregular, and while the strength was sufficient the effect was a lack of symmetry.

Crushed stone was used for the coarse aggregate in the concrete, and the sand and cement were frequently tested and found to meet the specifications of standard requirements in each instance.

The floor was finished by the use of a roller made of a 3-in. pipe, a method which has since been adopted in many instances for the finishing of concrete roads. The walls and columns were washed with grout after the forms were removed.

The Newton water supply is obtained from underground sources, and the temperature of the water only varies some 10 degrees Fahr. during the year. A covered reservoir containing such water is therefore subjected to but slight temperature stresses, and the structure was designed with the expectation that the whole work would be completed and filled with water during one season, thus doing away with the necessity for more than a minimum allowance for expansion and contraction during construction. The work was started so late in the season of 1916 that only the greater part of the floor area and walls were completed. The reinforcement in the floor, however, distributed the contraction stresses so that only hair cracks were apparent in the winter time, and the expansion joints provided in the walls proved adequate. It was noted that some of these latter joints did not open at all, and others a substantial amount during the cold weather.

The reservoir was completed during the autumn of 1917, but the water was not admitted during the winter as the controlling gates have not yet been placed in the gate chamber. This past winter was of unusual severity, the thermometer on occasions registering below zero for several days at a time, but it was observed that the temperature of the air in the interior of the empty sections did not fall below 33 degrees Fahr., and although the loam filling and the groined arch roof were frozen solid, as evidenced by the frost adhering to the under side of the arches, yet no cracks were apparent in the concrete of the roof, the only effect being that the construction joints along the crown of the arches opened up sufficiently to indicate their location, but without apparent impairment of the stability of the roof.

MEMOIRS OF DECEASED MEMBERS.

ELMER LAWRENCE CORTHELL.*

Born at South Abington, Mass., in 1840.
Died at Albany, N. Y., May 16, 1916.

Mr. Corthell entered Brown University, but after two years the Civil War broke out and he enlisted in the First Regiment, Rhode Island Light Artillery. He advanced from private to captain, and saw active service for four years in Virginia and North Carolina. After the war he resumed his college course and was graduated in 1867, receiving the degree of bachelor of arts. In the following year he received the degree of master of arts, and in 1894 the degree of doctor of science, both from his alma mater. He attained high rank in college, and achieved membership in the Phi Beta Kappa, an enviable distinction.

Upon graduating in 1867, he entered the office of Cushing & DeWitt, civil engineers in Providence, and engaged in general engineering practice. The following year he became assistant engineer on the Hannibal & Naples Railroad in Illinois, and in 1869 he had charge of location and construction of forty-five miles of the Hannibal & Central Missouri Railroad. In 1870 he became chief assistant engineer in the construction of the bridge over the Mississippi River at Hannibal, Mo., and from 1871 to 1874 he was chief engineer of the Sny Island Levee, fifty-one miles long, on the east bank of the Mississippi River. In 1873–74 he was also chief engineer for the bridge over the Mississippi River at Louisiana, Mo., for the Chicago & Alton Railway.

In 1874 he began his association with Mr. James B. Eads, who at that time was asking Congress to give him a contract for improving the mouth of the southwest pass of the Mississippi River by means of jetties. After the contract had been obtained, Mr. Corthell was invited to take charge of the engineering construction work and he was engaged upon this until 1880. This work resulted, as is well known, in increasing the depth of the channel from nine feet to over thirty feet, and in a vast increase in the commercial importance of the port of New Orleans.

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* Memoir prepared by George F. Swain.

In 1879–80 Mr. Corthell published an illustrated history of this undertaking. This work, in which Mr. Corthell showed remarkable skill, energy and resourcefulness, was the beginning of a long series of important works connected with the improvement of rivers and harbors in this and in foreign countries. Indeed, Mr. Corthell's principal life work may be said to have been in this branch of engineering, although he did much in other lines, and from 1881 to 1884 was chief engineer on the construction of the New York, West Shore & Buffalo Railroad and the New York, Ontario & Western Railway.

In 1880 Mr. Corthell went to the isthmus of Tehuantepec, Mexico, for Mr. Eads, to make surveys for the proposed ship railway, by which loaded vessels were to be carried bodily on rails across the isthmus in a cradle. From 1885 to 1887 he gave almost his entire attention to this project, and many engineers will remember the interesting model which he exhibited all over the country, illustrating the engineering details by which this novel enterprise was to be carried out. While the enterprise itself came to naught, the work of Mr. Corthell was of value in calling attention to the commercial aspect of the inter-oceanic canal projects.

In 1887 Mr. Corthell became associated with Mr. George S. Morrison in a partnership, in the course of which he had to do with the construction of important bridges over the Ohio and Missouri rivers. He also had to do with water works at Bismarck, Dak., with the construction of belt railroads at Chicago, and other works.

After 1888 Mr. Corthell continued his practice as a consulting engineer with offices in Chicago and New York, and his activity led him to become connected with many important works, among which may be mentioned the St. Louis bridge over the Mississippi River, the improvements at the mouth of the

Brazos River, Texas, railroad terminals at Chicago and New Orleans, the harbor at Tampico, Mexico, the Tehuantepec National Railroad, the improvement of harbors in the Argentine Republic and in Brazil, the barge canals for the state of New York, and other works too numerous to mention.

Mr. Corthell's engineering activity led him to give a great deal of attention to the study of questions of commerce and navigation, both from an engineering and a commercial point of view. He examined many harbors in Europe in connection with his work at Tampico and elsewhere, and he was very active in the international engineering congresses, being vice-president of the Seventh Congress, held at Brussels in 1898. Probably it is not too much to say that his acquaintance among foreign engineers was greater than that of any other American engineer. To the proceedings of engineering societies and congresses he contributed many important papers.

Mr. Corthell was also interested in engineering education. As a trustee of the University of Chicago he examined the leading technical schools of Europe to obtain information to aid the university. He was loyal to his alma mater, and left to that institution his valuable collection of books, pamphlets and reports.

Mr. Corthell was also deeply interested in the various engineering congresses which have been held, and gave time and effort to making them successful. He was active in connection with the Chicago Exposition, and by his engineering suggestions and plans did much to make it a success. He was chairman of the general committee of the engineering congress held at that time, the valuable results of which are comprised in a number of volumes of papers and documents by leading engineers from all parts of the world and in all branches of engineering. He was also vice-chairman of the international water commerce congress held at the same time.

Space will not permit of further notice of the numerous works and activities of Mr. Corthell, but it will be evident from what has been stated that he was one of the leading engineers of the country and that his energy seemed unlimited. He was always doing something, proposing something, accomplishing something, and spurring others on to emulate him. His success met with wide recognition. His advice was widely sought, his judgment universally respected, and he received many honors from scientific societies, governments, governmental departments and institutions of learning. The closing honor which came to him was his election as president of the American Society of Civil Engineers in 1916. While he, unfortunately, did not live to complete his term of office, it was a great satisfaction to his many friends to feel that this honor had been conferred upon him, and he himself appreciated it to its full extent.

Mr. Corthell made hosts of friends. He was always thoughtful and encouraging in his dealings with younger engineers; he was a man of the most kindly disposition and the widest sympathy, and his indefatigable industry and unwearied activity, which continued up to the day of his death, were an inspiration to all who knew him. He will not soon be forgotten by those who had the privilege of knowing him; and to know him was to love him.

JOHN WALDO ELLIS.*

Died October 30, 1916.

John Waldo Ellis was born in Woonsocket, R. I., on September 7, 1845, and finished his school education at New Hampton Institute, New Hampton, N. H. At the age of nineteen he entered the engineering force of the Boston, Hartford & Erie Railroad, then under construction from Waterbury, Conn., to Fishkill, N. Y. He afterwards was made division engineer of the Troy & Greenfield Railroad before the completion of the Hoosac Tunnel. From this road he went to the Norwich & Worcester Railroad, then building, and in 1869 came to Woonsocket, R. I., as chief engineer of the Providence & Worcester Railroad, at the same time opening an office for private practice in that place, which he maintained up to within a few years of his death.

Mr. Ellis held the position of chief engineer of the Providence & Worcester Railroad, up to the time that road was absorbed by the New York, Providence & Boston Railroad in 1888. Under his direction the road was double-tracked, many branch lines were constructed, the Wilkes-Barre Coal Pier and connection was constructed at Providence, and many bridges, stations and other structures were rebuilt. During this same period Mr. Ellis's private practice in Woonsocket was at its height, and many prominent engineers of the present day received their first experience in the old Main Street office. The design and direction of the construction of Nourse Mill of the Social Manufacturing Company, the Alice Mill of the Woonsocket Rubber Company, and numerous other industrial plants and enlargements in northern Rhode Island, were a part of the activities of his office.

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* Memoir prepared by J. Parker Snow, who states that he has taken his facts largely from the able memoir of Mr. Ellis by Lester W. Tucker, Proceedings, American Society of Civil Engineers, March, 1917, page 512.

From 1890 to the time of his death, Mr. Ellis was connected prominently with various engineering problems in New England. He was engineer for the Old Colony Railroad Company in the building of the Providence passenger terminal, and engineer inspector of the Boston & Providence Railroad from the time of its lease to the Old Colony Railroad until his death. His connection with various grade-crossing matters in Massachusetts and Rhode Island included many of the important problems in that line. He was one of the commissioners for the elimination of grade crossings in Lowell, in Athol and in Orange, Mass., and was employed as engineering expert by the cities of Lynn, Worcester, Cambridge, Fall River, Taunton, Haverhill, Readville and a large number of other towns.

As a water-works expert, Mr. Ellis was among the foremost in New England, serving as one of the commissioners in the valuation of the Newburyport and of Gloucester water works when these were taken over by these cities. He was also a member of the commissions in the diversion claims against the city of Pittsfield and the claim of the Nassau Paper Company against the Metropolitan Water Board.

As a town and city engineer, Mr. Ellis was especially active, serving as town engineer of Woonsocket from 1870 to the time it became a city in 1888. He also served as engineer for the town of Blackstone, and for other surrounding towns, up to the time of the closing out of his private practice.

As a hydraulic engineer, Mr. Ellis was very active, and the Blackstone and other rivers in Massachusetts and Rhode Island have many dams constructed under his direction. The most prominent of these are the Lonsdale, Ashton and Wilkinsonville dams on the Blackstone; the Slatersville Reservoir Dam and Middle Dam on the Branch River, and the Georgiaville Dam on the Woonasquatucket, in Rhode Island.

He was elected a director of the Providence Gas Company on February 26, 1900. This followed the successful completion under his engineering supervision of the difficult and important work of laying a submarine pipe across a narrow arm of the bay, from Providence to East Providence. He was elected president and general manager of the company on March 4, 1901, and discharged the duties of this office for more than fifteen years and until his death. During this time large extensions of the plant were made, including the first installation of Dessau vertical retorts in America.

Notwithstanding his many engineering engagements and business connections, Mr. Ellis found time to be a most efficient director and manager in other fields. He was a member of the board of directors of the Industrial Trust Company of Providence, and chairman of the board of the Woonsocket branch of that Company. He was a director in the Woonsocket Rubber Company and many other corporations. He was also a trustee of the Woonsocket Institution for Savings, from 1876 to 1908, and a trustee of the Woonsocket hospital from its founding in 1890 to the time of his death. Although a prominent member of many clubs and social organizations, Mr. Ellis had no connection with any fraternal or secret orders. He was a member of the American Society of Civil Engineers and served as a director from 1904 to 1906 inclusive. He was also a member of the New England Water Works Association.

His principal diversion in his leisure was that of driving. From the time when he established his home in Woonsocket his stable always contained at least one good, blooded trotting horse, and, when the roads were good or the sleighing at its best, Mr. Ellis was to be seen among the fastest of those on the speedways. He was a member of the Woonsocket Driving Club, the Roger Williams Driving Club of Providence, and the Metropolitan Driving Club of Boston, and it is interesting to note that only three weeks before his death he drove on the track of the latter club.

Mr. Ellis was a prominent figure in the political field of Woonsocket for many years. He served as alderman from his ward, and was president of the board during this service. In 1904 he was elected state senator from his city and served on many important committees.

He was a member of the board of trustees of the First Universalist Church for many years.

Mr. Ellis was a man of marked ability and superb courage, and was recognized as a leader in any activity into which he entered. His business ability, keen foresight and tremendous energy, his unimpeachable integrity, faithful attention to duty and resourcefulness in difficulties, made him a most valuable adviser and representative in engineering, civic and social lines. His wide acquaintance among prominent men gave opportunities for the exercise of these attributes to a remarkable extent. It is seldom that work of such varied character is executed with such invariable success as attended the career of Mr. Ellis. The scope of his talents was wide, and indicated a breadth of mentality seldom found in one man.

Mr. Ellis was married, on May 23, 1870, to Mary F. Howe, who, with one son and two daughters, survives him.

He was elected a member of the Boston Society of Civil Engineers on May 19, 1896, and served as President for one year from March 15, 1905.

FRANKLIN BUCHANAN LOCKE.*

Born at Hampton, N. H., February 23, 1857.
Died May 11, 1917.

Franklin B. Locke came of New England ancestry, and was well known for many years in New England as a capable and resourceful engineer. He was a lineal descendant of Capt. John Locke, who is described as a man of prominent position among the early settlers of New Hampshire, and was finally killed by the Indians in 1696.

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* Memoir prepared by George F. Swain.

He received his engineering education at the Massachusetts Institute of Technology, where he was a member of the class of 1877, but discontinued his course after three years to engage in the work of construction of the Hoosac Tunnel. His elder brother, Augustus W. Locke, also an eminent engineer, was engaged upon the same work, and after the completion of the tunnel became superintendent of the Troy & Greenfield road. Frank was assistant engineer on the tunnel until 1881, when he formed a partnership with his brother, and the firm became known as perhaps the leading engineering firm of western Massachusetts.

His work was of great variety, covering the fields of railroad engineering, municipal engineering, and even mining engineering. One of his earliest engagements was as engineer for the extension of the water-works and drainage system of North Adams, Mass. He also had charge of the double-tracking of the state road east of the tunnel and of the masonry. In 1881–82 he was a principal assistant engineer on the Buffalo, Rochester & Pittsburg Railway on that portion of the line between Salamanca, N. Y., and Ridgway, Pa. He did some valuable and interesting location work on the Mountain Division south of Bradford, Pa., through a country parallel to the line of the Erie Railroad over the Kinzua Viaduct. He resigned this work owing to poor health, and spent a time traveling in Europe, visiting most of the great Alpine tunnels and inspecting European railways. Returning to this country, he was engineer of maintenance of way of the Troy & Greenfield Railroad, which embraces the Hoosac Tunnel. He was also chief engineer of the Hoosac Valley Electric Railroad, which runs through Adams, North Adams and Williamstown, and of a branch of the Fitchburg Railroad, which he constructed. He also investigated and reported upon numerous railroad and mining properties in the west, and for a time was engineer for the Michigan Hydraulic Mining Company in Idaho, and also for some mines in Utah. In connection with his brother he became greatly interested in the problem of abolishing railroad grade-crossings in Massachusetts, and was connected with projects for several works of this kind.

Finally settling in North Adams, Mass., he held the office of city engineer for a number of terms, and also the office of commissioner of public works. Indeed, for many years he was depended upon to take the lead in the engineering work of the city of North Adams. While in these positions he had to do with the construction of water works, sewers, roads and bridges. He built many roads, and was an authority on their construction. He was, probably more than any one else, responsible for the successful recent extension of the North Adams water works, which he planned and began.

One of Mr. Locke's most recent activities was in connection with the location and construction of the so-called Mohawk Trail, a state road across the Berkshire Hills between North Adams on the west and the Deerfield Valley on the east. Indeed, he is known in the vicinity of North Adams as " the father of the Mohawk Trail." While he started the movement for this road and surveyed a line, his route was not adopted by the state officials, although many considered it the best line. At any rate, Mr. Locke was the man who first conceived the idea of this trail.

Mr. Locke had traveled much in this country and abroad, had assimilated his experience and had gathered a great deal of knowledge. He had read widely and intelligently. Some people travel and read, but do not learn; but he was not of this sort. His breadth of interest was greater than that of most engineers. He had an artistic nature, and had even given some attention to art. He was modest, retiring, and if he had any fault it was that he did not push himself to the extent that his ability warranted, for he was really a man of fine perception, strong common-sense, and exceedingly capable as an engineer. With greater stimulus he might have made himself better known, and might have achieved a greater measure of what is usually, though probably mistakenly, termed success; but he preferred the quiet retirement of his home and the society of his friends and of his books, and probably after all he derived in that way a greater measure of real satisfaction than falls to the lot of those who are more prominent or pushing in the battle of life. He was sociable, upright, hopeful, courageous, conscientious and true. He had a high conception of the calling of the engineer, and no one could ever say that he had failed in his duties toward his fellow-men. He made many friends and lost few. He was beloved by all who knew him. His judgment was relied upon by all who had had opportunity to test it, and his death left a gap in the hearts of his friends and in the engineering circles in which he moved which will be indeed difficult to fill. Even after his health became impaired his advice was sought and relied upon. In his home town, where his friends were legion, he will be sadly missed; but as long as a good water supply and the beauties of nature are appreciated his name will be held in affectionate remembrance.

Mr. Locke had been in failing health since 1907. Indeed, he had never been extremely robust. Nevertheless he continued to serve his state to the extent that his strength would permit. In 1914 his health broke down, and he had to give up public responsibility, and resigned as commissioner of publc works. A trip south benefited him for a time, but afforded no permanent relief. He died in a hospital in Boston quite suddenly, when his friends thought he was out of danger.

Mr. Locke was a member of the American Society of Civil Engineers which he joined March 1, 1893, and also of the Boston Society of Civil Engineers, the American Institute of Mining Engineers, the North Adams Club and the Berkshire Club.

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